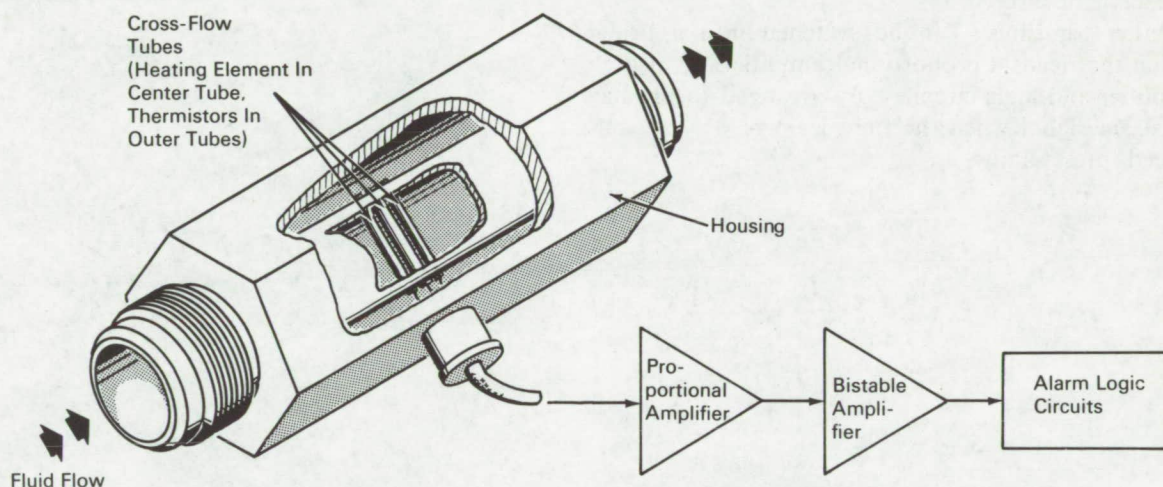


NASA TECH BRIEF



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Wide-Range Instrument Monitors Flow Rates of Chemically Active Fluids



The problem:

To devise an in-line transducer system that will measure low and high flow rates of propellant fluids consisting of strong oxidants (e.g., nitrogen tetroxide) or thermally unstable fuels (e.g., hydrazine). The low-flow transducer is to be operated intermittently whenever it is desired to check for low-flow leakage (10 cc per hour to 10,000 cc per hour). The high-flow transducer, to be used for continuous operation (except during low-flow leakage checks), is required to provide flow-rate indications whenever the propellant flow rate ranges from 1000 cc per hour to 2×10^6 cc per hour. Conventional electrothermal flowmeters do not meet requirements with respect to allowable electrical power consumption and propellant compatibility.

The solution:

A system incorporating two specially designed electrothermal transducers, one operating as a low-

flow transducer and the other as a high-flow transducer. Each consists of separate heater and temperature-sensing elements sealed in small stainless-steel tubes that are positioned in a cross-flow configuration and welded to the walls of a stainless-steel tube, which is then welded into a stainless-steel outer housing.

How it's done:

Two thermistors which serve as temperature sensors in the low-flow transducer illustrated are arranged in a thermally symmetrical configuration with respect to the heater element to provide differential temperature response to all effects except those due to flow. The high-flow, cross-tube transducer is identical in principle to the standard heated-wall electrothermal flowmeter. The primary difference is that the new high-flow configuration measures the heat transfer coefficient at the leading edge of a small cylinder, while the heated-wall meter measures the heat transfer coefficient at the wall of the main flow tube. The

(continued overleaf)

total heated area exposed in the high-flow cross-tube transducer is greatly reduced compared to the heated-wall system and provides for much greater sensitivity and correspondingly lower input power.

The thermistor sensing elements used in both transducers are sealed in glass and the units are cast into thermally conductive epoxy resin plugs which snugly fit the bore of the cross-flow tubes. The potted thermistors are then pressed into place and retained with a small spot of epoxy resin. The heater resistors are positioned in the cross tubes and bonded at both ends with epoxy resin. All electrical leads are then resistance-welded to nickel ribbons which are welded to an electrical connector having a stainless-steel body and gold-plated stainless-steel pins. The pins are individually insulated from the connector body by silicoceramic inserts.

Either transducer can be switched into a bridge circuit that feeds a proportional amplifier. A bistable amplifier and logic circuitry are arranged to produce an alarm signal when the fluid leakage or flow rate exceeds preset limits.

Notes:

1. Less than 2 watts at 28 volts are consumed by the instrument in either range.
2. Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Manned Spacecraft Center
Houston, Texas, 77058
Reference: B66-10205

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C., 20546.

Source: Spacelabs, Inc.,
under contract to
Manned Spacecraft Center
(MSC-186)